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(54) Title: DEVICE FOR ADMIXING A FIRST FLUID INTO A SECOND FLUID			
(57) Abstract			
<p>The present invention relates to a device for admixing a first fluid into a second fluid, comprising a housing (12) with a rotationally symmetrical chamber (30), here referred to as rotation chamber, and arranged with an inlet (24, 26) for the second fluid and an outlet (46) for the mixed fluids, the distance from the centre shaft of the housing (12) to its inner wall decreasing continuously from the inlet to the outlet in at least one section (36) of the said rotation chamber (30), and also means (14, 50, 90) for setting the second fluid in rotation along the inner wall of the said rotation chamber. The invention is characterized by means (14, 50, 80, 82) for adding the first fluid into the vortex which is formed when the second fluid is rotating in the said rotation chamber (30).</p>			

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DEVICE FOR ADMIXING A FIRST FLUID INTO A SECOND FLUID

TECHNICAL FIELD

The present invention relates to a device for
5 mixing a first fluid into a second fluid, comprising a
housing with a rotationally symmetrical rotation chamber
having an inlet for the second fluid and an outlet for
the mixed fluids, the internal diameter of the housing
decreasing continuously from the inlet to the outlet in
10 at least one section of the rotation chamber converging
in the direction towards the shaft, and also means for
setting the second fluid in rotation along the inner wall
of the rotation chamber.

15 PRIOR ART

In the chemical pulp industry it is extremely
common to admix different fluids into pulp suspensions at
different stages in the process, for example chlorine
dioxide or other bleaching agents in liquid or gaseous
20 form in a bleaching department chain. In pressurized
systems, such as these are, it has been found to be
difficult to supply and admix these fluids, especially in
gaseous form, since they are difficult to pressurize to
system pressures, which may be up to 10 bar overpressure.
25 To make the admixing easier, it would be desirable to
reduce the pressure at the point of addition. However,
since the pressure across a mixer device should
preferably not change appreciably, it would be necessary
to raise the pressure again after the said pressure
30 reduction. To this day, as far as the inventors are
aware, no device has been produced which is able to do
this.

DESCRIPTION OF THE INVENTION

35 The object of the present invention is to
overcome the difficulties encountered when admixing gas,
in particular, in pressurized systems. This object is
achieved by a device of the type mentioned in the
introduction, which is characterized by means for adding
40 the first fluid into the vortex which is formed when the

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second fluid is rotating in the said chamber. Further characteristics and aspects of the invention will be evident from the patent claims and from the following description of a preferred embodiment.

5

BRIEF DESCRIPTION OF THE FIGURES

A preferred embodiment of the present invention will be described hereinafter with reference to the drawing figures, in which:

- 10 Figure 1 is a side view of the device according to the invention,
Figure 2 is a partial view, in longitudinal section, of those parts of the device which participate in the admixing,
15 Figure 3 is a view along the line III-III in Figure 2,
Figure 4 is a perspective view of that part of a rotor which is provided with acceleration vanes, and
Figure 5 is a perspective view of that part of a rotor which is provided with pressure-intensifying
20 vanes and vortex breakers.

DESCRIPTION OF A PREFERRED EMBODIMENT

A preferred embodiment of the device according to the invention will be described with reference to the figures. According to Figure 1, it comprises a stand 10 on which a housing 12 is fitted. A shaft 14 runs through the housing 12 and is rotatably mounted in two bearing housings 16, which are also fitted on the stand 10. A suitable drive mechanism (not shown) is connected to the shaft 14. The shaft 14 runs through two end walls 20, 22, here referred to as feed end wall 20 and discharge end wall 22, respectively, which end walls are fitted in a detachable manner on the housing 12 with the aid of screws, for example, and are sealed off from the housing 12. The through-passages for the shaft 14 in the end walls 20, 22 are sealed off in a suitable manner. Arranged at the feed end wall 20 there is an inlet 24 for the fluid which is to be treated, here referred to as the

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second fluid, in the form of a pipe connection. The inlet pipe 24 merges into the feed end wall 20 in an inlet passage 26, Figure 2, which in this embodiment is directed obliquely in towards the shaft 14.

5 The inlet passage 26 is in communication with a rotation chamber 30 in the housing 12, which rotation chamber 30 is rotationally symmetrical. The circular inner side 32 of the feed end wall 20 is essentially plane and at right angles to the longitudinal direction 10 of the shaft 14. Viewed in the direction from the feed end wall 20 towards the discharge end wall 22, the rotation chamber 30 has a first cylindrical wall section 34 which runs essentially parallel to the longitudinal direction of the shaft 14 and at a distance D₁ from the 15 shaft 14. The first wall section 34 merges into a second conical wall section 36 which forms an angle α with respect to a plane parallel to the longitudinal direction of the shaft 14, so that the distance from the second wall section 36 to the shaft 14 decreases in the 20 direction towards the discharge end wall 22. The second wall section 36 finishes in a rounded part 38 with a radius of curvature R₁ in order to merge into a third plane wall section 40 which is essentially at right angles to the longitudinal direction of the shaft 14. The 25 rounded part 38 is at a distance D₂ from the shaft which is less than D₁, and the second wall section 36 thus acquires a funnel-shaped appearance in this section of the rotation chamber 30. The third wall section 40 merges at its periphery into the contact surface for the 30 discharge end wall 22.

The rotation chamber 30 continues in the discharge end wall 22 via a fourth cylindrical wall section 42, which also runs essentially parallel to the longitudinal direction of the shaft 14 and at a distance 35 D₃ from the shaft. The rotation chamber 30 finishes with a fifth plane, circular wall section 44 which is at right angles to the longitudinal direction of the shaft 14. A pipe connection 46 is arranged on the discharge end wall

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22, which pipe connection 46 acts as an outlet for the mixed media. The outlet 46 is arranged tangentially at a site on the fourth wall section 42.

A rotationally symmetrical body 50, hereinafter referred to as the rotor, is secured on the shaft 14 with the aid of, for example, key joints inside the rotation chamber. In the preferred embodiment, the rotor 50 is divided in two along a cut S transverse to the longitudinal direction of the shaft in order to allow the 10 rotor to be fitted in the rotation chamber 30. The two parts 50A and 50B of the rotor are fitted together in a suitable way, for example with screw connections. Viewed from the feed end wall 20 to the discharge end wall 22, the rotor 50 has a first wall section 52 which is 15 parallel with the first wall section 32 of the rotation chamber 30 and at a distance from the latter, so that a column-shaped space 54 is formed between these wall sections, viewed in a longitudinal section along the shaft 14. The first, plane wall section 52 of the disc 20 50A of the rotor 50 merges into a second wall section 56 which is in turn essentially parallel to the second conical wall section 36 of the rotation chamber, and at a distance from this, so that here too a column-shaped, converging space 58 is obtained. The second wall section 25 56 of the rotor 50 merges, at its inner part nearest the shaft 14, into a rounded third wall section 60 with a radius of curvature R_2 in order thereafter to continue, in the second disc 50B, in an essentially conical fourth wall section 62 which forms an angle β with respect to 30 the longitudinal direction of the shaft 14, in such a way that the distance from the fourth wall section 62 of the rotor to the shaft 14 increases when viewed from the feed end wall 20 towards the discharge end wall 22.

The fourth wall section 62 of the rotor merges 35 into a fifth wall section 64 which is essentially parallel to the third wall section 40 of the rotation chamber and at a distance from this wall. A gap 66 is formed between the rounded section 38 of the rotation

chamber and the fourth wall section 62 of the rotor, and a gap 68 is also formed between the third wall section 40 of the rotation chamber and the fifth wall section 64 of the rotor. As a result of the above-described 5 configuration of the walls of the rotation chamber and the rotor, a column-shaped passage is obtained, in longitudinal section, which runs through the whole housing from the inlet to the outlet.

The shaft 14 is provided with a longitudinal 10 cavity 80 for the fluid which is to be admixed, here referred to as the first fluid, for at least some distance into the rotation chamber. This cavity 80 communicates with a transverse passage 82, which passage 15 also extends through the rotor 50 and opens out approximately at the transition between the third rounded wall section 60 of the rotor and its fourth wall section 62. In the preferred embodiment, the passage 82 does not open out in the wall surfaces of the rotor at right angles to these, but instead tangentially with respect to 20 the direction of rotation, Figure 3, that is to say the passage 82 bends off just before it reaches the third wall section 60. In the embodiment shown, the rotor 50 is arranged with one outlet for the first fluid, but it can of course be provided with several tangentially directed 25 outlets on the periphery of the rotor. The first fluid is supplied from a source (not shown) via pipe lines 84, Figure 1, to a packing box 86 which bears sealingly around the shaft 14, and it is conveyed thence into the cavity 80 in the shaft. The space 66 downstream of the 30 passages for the second fluid, viewed in the direction of flow, is referred to here as the mixing zone.

The rotor is provided with a first set of vanes 90, here referred to as acceleration vanes, Figure 4, secured on the first wall section 52 of the rotor. The 35 vanes 90 extend from the shaft 14 out towards, and closely adjacent to, the first wall section 32 of the rotation chamber. The vanes 90 are in addition drawn round the corner between the first and second wall

sections 52 and 56, respectively, of the rotor and extend some distance along the second wall section 34 of the rotation chamber. The space in which the acceleration vanes 90 move during rotation is referred to here as the 5 activation zone. According to Figure 3, the acceleration vanes 90 are designed straight and radial, but they can of course be curved.

The second disc 50B of the rotor 50 is also provided with a second set of vanes 92, here referred to 10 as pressure-intensifying vanes, Figure 5, which are secured on the fourth wall section and fifth wall section 62, 64 of the rotor and in cross-section take up in principle the whole of column 68. The pressure-intensifying vanes 92 can be designed in a similar way to 15 the acceleration vanes 90. The rotor 50 is also provided with vane blades 94, here referred to as vortex breakers, which extend into the space 66 between the fourth wall section 62 of the rotor and the curve 38 of the wall section in the rotation chamber and finish immediately 20 downstream of the inlet for the first fluid, viewed in the direction of flcw.

The vortex breakers 94 are preferably arranged on the pressure-intensifying vanes 92 close to the fifth wall section 64 of the rotor 50, in such a way that they 25 form a continuation of these vanes into the mixing zone and are preferably arranged essentially at right angles to the direction of rotation. If necessary, the vortex breakers 94 can also be arranged on the fourth wall section 62 of the rotor 50 between the pressure-intensifying vanes 92. In the figures, both the 30 acceleration vanes 90 and the pressure-intensifying vanes 92 are designed as six blades, although they can of course be present in another number. In addition, it may be advantageous to have different numbers of first and 35 second vanes 90, 92 in order to prevent pulsing within the system. In this case, the first disc 50A with the acceleration wheel can be conceived of having seven vane blades 90 and the second disc 50B with the pressure-

intensifying wheel of having six vane blades 92, although other designs are of course conceivable.

The device functions as follows. The shaft 14, and consequently the rotor 50, and the acceleration vanes 90 and pressure-intensifying vanes 92 on this rotor 50, are brought into rotation with the aid of a suitable drive mechanism (not shown) which is connected to the shaft 14. The suspension which is to be treated is led in via the pipe connection 24 to the inlet passage 26 and 10 then into the column-shaped activation zone 54 near the shaft 14. The suspension is brought into rotation by the acceleration vanes 90 and is thrown out towards the periphery. The acceleration of the suspension means that the latter acquires a higher peripheral velocity than the 15 velocity of the rotor 50. The rotating suspension is then led down along the funnel-shaped converging wall section 36 in the rotation chamber 30 where its peripheral velocity increases the nearer it comes to the centre. The funnel-shaped wall section 36 thus comes to act as a 20 cyclone, and the suspension comes to gyrate around in this part, with an epicentre around the shaft 14.

The increase in peripheral velocity in this part gives rise to a considerable reduction in the pressure of the suspension, and this reduction in pressure is greater 25 the closer to the epicentre. This reduction in pressure is desirable for the addition of the first fluid, and especially gas, since gas, such as chlorine dioxide, is difficult to pressurize. The inlet 82 for the first fluid is therefore arranged as near to the epicentre as 30 possible, where the pressure is lowest. The first fluid is introduced through the cavity 80 in the shaft 14 and the passage 82 in the rotor. Since the outlet or the outlets are angled tangentially with respect to the direction of rotation, the first fluid is, so to speak, 35 spread out around the narrowest section of the rotor and is entrained by the gyrating suspension. It is important that the first fluid to be admixed is introduced as smoothly as possible since the least disturbance

immediately gives rise to an increase in pressure and poorer possibilities of good admixing. Tests have shown that the pressure of the suspension nearest the shaft in the area where the first fluid is added is atmospheric 5 pressure or even below this, that is to say that a negative pressure is created there. This means that the first fluid is in principle sucked in or is at least supplied at extremely low pressure.

The vortex breakers 94 are arranged immediately 10 downstream of the mixing zone, and since the suspension has a greater velocity than the rotor, the suspension strikes the side surfaces of the vortex breakers 94 and is decelerated. This deceleration gives rise to considerable turbulence in this area and consequently 15 good admixing of the first fluid into the second, and good homogenization. The kinetic energy which the gyrating suspension possesses is therefore used for mixing of the two fluids. Since the pressure of the suspension after this has dropped substantially, it is 20 led out to the pressure-intensifying vanes 92 where its pressure is intensified. Depending on the configuration of the pressure-intensifying vanes and their radius, the suspension is returned to the desired pressure. The pressure-intensified, mixed suspension is then led out 25 through the tangential outlet in the discharge end wall and is conveyed onwards in the system. In the illustrated embodiment, the distance D_3 is approximately equal to the distance D_1 , that is to say the diameter of the pressure-intensifying wheel is approximately equal to that of the 30 acceleration wheel, which means that the pressure will be approximately the same at the discharge side as at the admission side.

The device can be manufactured using any suitable material whatsoever. However, it is expedient for the 35 wall surfaces of the rotation chamber to be clad with a hard-wearing material, especially in the admixing zone, since the suspension gyrates at a high velocity along these surfaces and the suspension often contains a

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certain, albeit small, amount of sand and similar particles which wear the walls of the chamber, since the density of these particles causes them to lie in a layer furthest to the outside in the gyrating suspension.

5 It will be understood that the device according to the present invention is not limited to the embodiment which has been described above and which is shown in the figures, and instead it can be modified within the scope of the attached patent claims. Thus, it is possible for
10 the suspension to be set in rotation in the chamber in another way, for example by means of tangential inlets. It is also possible to add the first fluid using other suitable members which are able to introduce the first fluid at or near to the epicentre. It is also conceivable
15 for the vortex breakers to be arranged and/or designed in any desired way which is capable of breaking up the rotation of the second fluid. The same applies to the intensification of the pressure of the mixed suspension, which can be effected in a number of different ways so as
20 to achieve the desired pressure after mixing. In addition, the wall sections of the rotation chamber and of the rotor, and the angles and curvatures of the wall sections, can be designed in different ways so as to achieve the desired flow and admixing.

PATENT CLAIMS

1. Device for admixing a first fluid into a second fluid, comprising a housing (12) with a rotationally symmetrical chamber (30), here referred to as rotation chamber, having an inlet (24, 26) for the second fluid and an outlet (46) for the mixed fluids, the distance from the centre shaft of the housing (12) to its inner wall decreasing continuously from the inlet to the outlet 10 in at least one section (36) of the rotation chamber (30) converging in the direction towards the shaft, and also means (14, 50, 90) for setting the second fluid in rotation along the inner wall of the said rotation chamber,
15 characterized by means (14, 50, 80, 82) for adding the first fluid into the vortex which is formed when the second fluid is rotating in the said rotation chamber (30).

20 2. Device according to Claim 1,
characterized by means (14, 50, 92) for intensifying the pressure of the mixed fluids before they leave the said outlet (46).

25 3. Device according to Claim 1 or 2,
characterized by means (92) for breaking up the rotation of the second fluid at, or close to, downstream of, the area where the first fluid is added.

30 4. Device according to Claim 1,
characterized in that a rotatable shaft (14) runs through the centre of the said rotation chamber (30), in that a rotationally symmetrical rotor (50) is secured on the said shaft (14), in that members are 35 arranged for bringing the said shaft (14) and rotor (50) into rotation, in that vanes (90), here referred to as acceleration vanes, are arranged on the said rotor closely adjacent to the said inlet (24, 26) for the

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second fluid, which vanes (90) are able to throw the second fluid outwards and bring it into rotation towards the said converging section (36) of the rotation chamber (30), and in that the said members for adding the first 5 fluid are arranged closely adjacent to the section (38) of the said rotation chamber (30) which has the smallest diameter.

5. Device according to Claim 4,
10 characterized in that the said members for adding the said first fluid comprise a cavity (80) in the said shaft (14) and at least one passage (82) in the said rotor (50) between the said cavity (80) and the said rotation chamber (30).

15

6. Device according to Claim 5,
characterized in that the outlet of the said passage (82) in the rotation chamber (30) is directed tangentially with respect to the direction of 20 rotation.

7. Device according to Claims 4 to 6,
characterized in that the said rotor (50) also comprises a second set of vanes (92), here referred 25 to as pressure-intensifying vanes, arranged downstream of the site for admixing the first fluid into the second fluid, as viewed in the direction of flow in the device, which second set of vanes (92) is able to increase the pressure of the mixed fluids.

30

8. Device according to any of Claims 4 - 7,
characterized in that the rotor (50) comprises vane blades (94) arranged on the said rotor (50) downstream of, and closely adjacent to, the site for 35 addition of the first fluid into the rotation chamber (30).

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9. Device according to Claim 8,
characterized in that the said vane blades
(94) are arranged essentially at right angles to the
direction of rotation of the second fluid in the rotation
5 chamber (30).

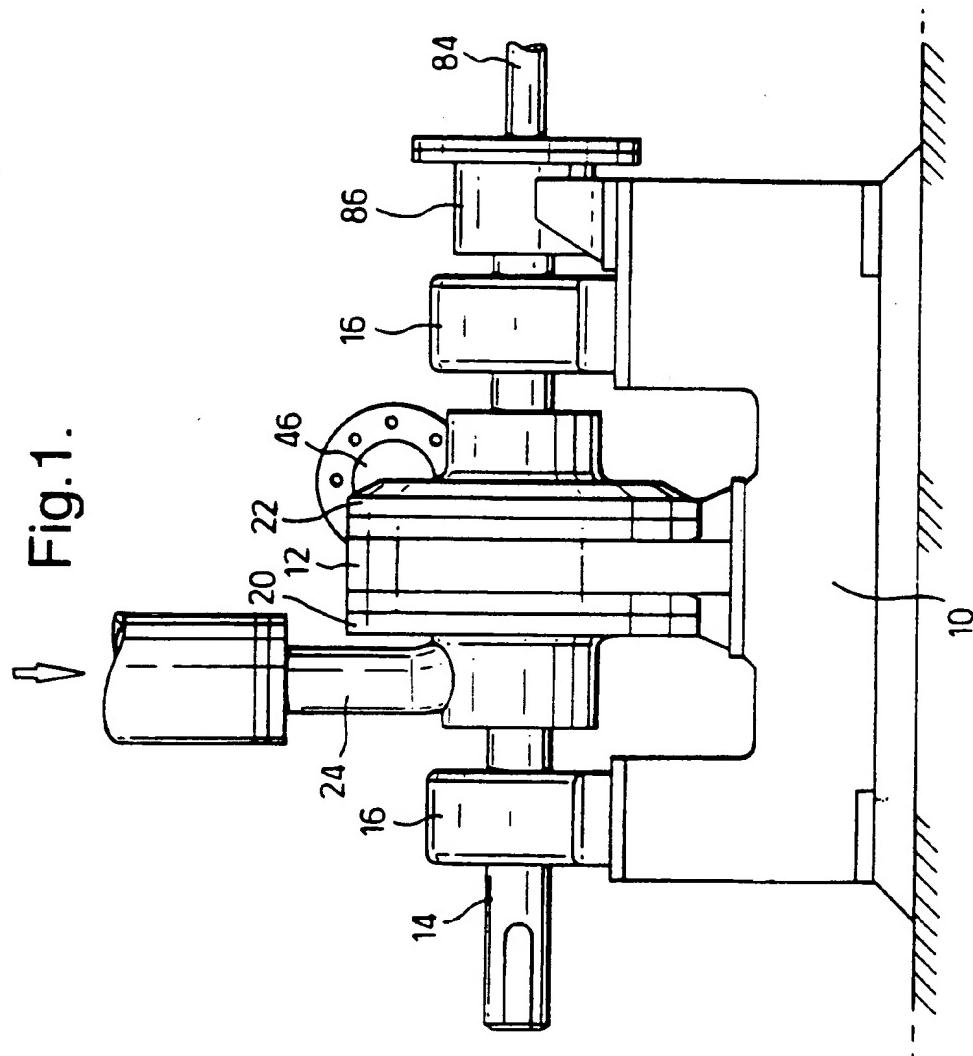
10. Device according to either of Claims 8 - 9,
characterized in that the said vane blades
(94) constitute an integral part of the said pressure-
10 intensifying vanes (92).

11. Device according to Claim 10,
characterized in that the number of said
vane blades is greater than the number of pressure-
15 intensifying vanes.

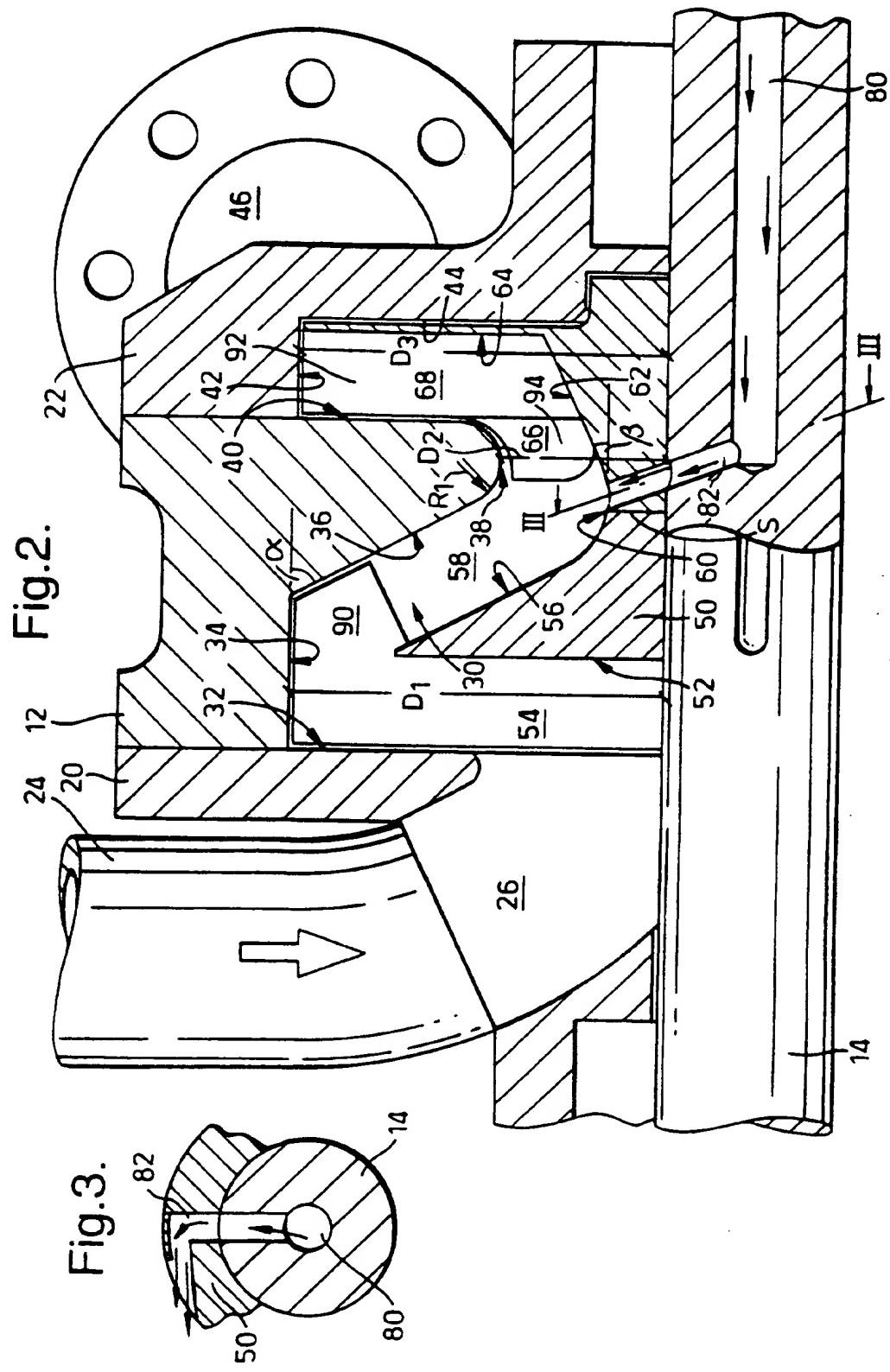
12. Device according to any one of the preceding
claims, characterized in that the wall
sections of the rotation chamber (30), at least in the
20 converging section (36, 38) thereof, are clad with
material which is resistant to wear.

1/3

Fig. 1.



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3/3

Fig.4.

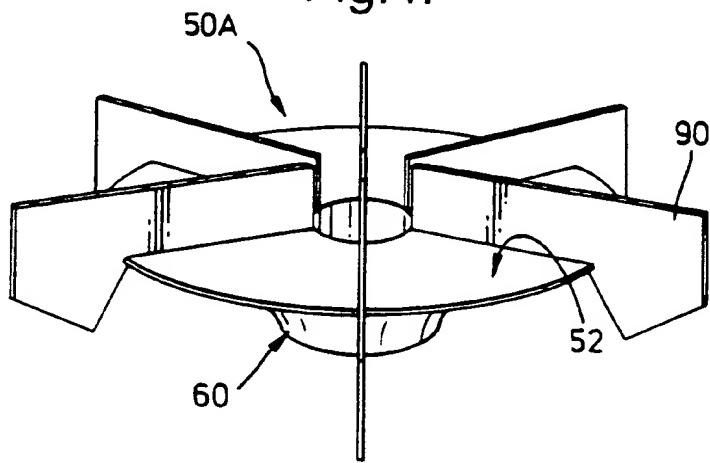
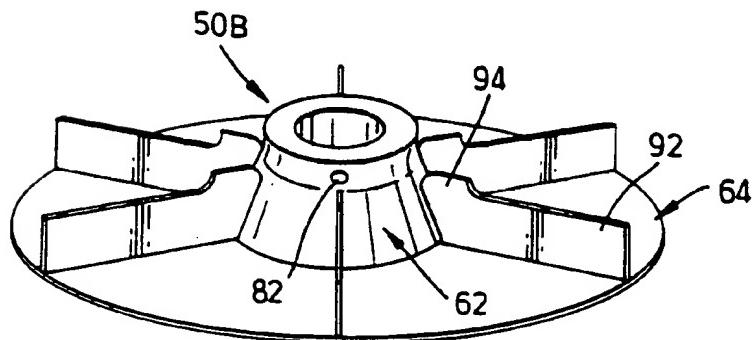


Fig.5.



INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 96/00443

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B01F 3/08, D21C 9/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B01F, D21C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DIALOG

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4388045 A (W.E. SIMON), 14 June 1983 (14.06.83), abstract, figure	1
A	---	2-12

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INTERNATIONAL SEARCH REPORT

Information on patent family members

01/07/96

International application No.

PCT/SE 96/00443

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4388045	14/06/83	NONE	